IMAGING APPARATUS AND IMAGE SENSOR INCLUDING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from U.S. Provisional Patent Application No. 62/198,268, filed on Jul. 29, 2015, and Korean Patent Application No. 10-2016-0044268, filed on Apr. 11, 2016, in the Korean Intellectual Property Office, the disclosures of which are incorporated herein by reference in their respective entireties.

BACKGROUND

[0002] 1. Field

[0003] Apparatuses and methods consistent with exemplary embodiments relate to image sensors.

[0004] 2. Description of the Related Art

[0005] Optical sensors including semiconductor sensor arrays may be used in mobile devices, wearable devices, and the Internet of Things. Although such devices should be small, it is difficult to reduce the thicknesses of imaging apparatuses included in these devices.

[0006] Also, as demand for a 3-dimensional image sensor to be used in the Internet of Things, game devices, and other mobiles has increased, an optical system capable of controlling pathways of light incident onto the 3-dimensional image sensor is needed. However, because a conventional 3-dimensional image sensor includes complicated optical lenses, it has been difficult to manufacture an appropriate 3-dimensional image sensor for use in such devices.

SUMMARY

[0007] Exemplary embodiments may address at least the above problems and/or disadvantages and other disadvantages not described above. Also, the exemplary embodiments are not required to overcome the disadvantages described above, and may not overcome any of the problems described above.

[0008] Provided are image sensors that may be configured to have a small size and may be configured to obtain 3-dimensional information about an object.

[0009] According to an aspect of an exemplary embodiment, an image sensor includes an image sensor includes a substrate, thin lenses disposed on a first surface of the substrate and configured to concentrate lights incident on the first surface, and light-sensing cells disposed on a second surface of the substrate, the second surface facing the first surface, and the light-sensing cells being configured to sense lights passing through the thin lenses, and generate electrical signals based on the sensed lights. A first thin lens and second thin lens of the thin lenses are configured to concentrate a first light and a second light, respectively, of the incident lights onto the light-sensing cells, the first light having a different wavelength than the second light.

[0010] The substrate may include sub-substrates, and the thin lenses and the light-sensing cells may be respectively disposed on a first surface and a second surface of each of the sub-substrates.

[0011] Each of the thin lenses may include scatterers, and each of the scatterers may have a pillar structure.

[0012] An interval distance between a pair of the scatterers may be less than a respective wavelength of light concentrated by a respective one among the thin lenses.

[0013] A height of the scatterers may be less than a respective wavelength of light concentrated by a respective one among the thin lenses.

[0014] The scatterers may include at least one from among silicon, gallium phosphide, SiC, SiN, and TiO_2.

[0015] Shapes of the scatterers and interval distances between respective pairs of the scatterers may vary with a respective wavelength of light concentrated by a respective one among the thin lenses.

[0016] The image sensor may further include light filters, each of the light filters being configured to filter a respective wavelength of light incident on a respective one among the light-sensing cells.

[0017] The image sensor may further include an image synthesizer configured to generate a multi-color image by synthesizing images of different colors, and at least two among the light-sensing cells may produce the images of different colors.

[0018] The image sensor may further include an image synthesizer configured to generate a stereo image based on images that are produced by the light-sensing cells.

[0019] The image synthesizer may be further configured to extract depth information about an object appearing in the stereo image.

[0020] According to an aspect of an exemplary embodiment, an image sensor includes a substrate, thin lenses disposed on a first surface of the substrate and configured to concentrate lights incident on the first surface, and light-sensing cells disposed on a second surface of the substrate, the second surface facing the first surface, and the light-sensing cells being configured to sense lights passing through the thin lenses, and generate electrical signals based on the sensed lights. A first thin lens and second thin lens of the thin lenses may be configured to concentrate a first light and a second light, respectively, of the incident lights to have different focal lengths.

[0021] The substrate may include sub-substrates, and the thin lenses and the light-sensing cells may be respectively disposed on a first surface and a second surface of each of the sub-substrates.

[0022] The concentrated lights may have predetermined wavelengths.

[0023] Each of the thin lenses may include scatterers, and each of the scatterers may have a pillar structure.

[0024] An interval distance between a pair of the scatterers may be less than a respective wavelength of light concentrated by a respective one among the thin lenses.

[0025] A height of the scatterers may be less than a respective wavelength of light concentrated by a respective one among the thin lenses.

[0026] Shapes of the scatterers and interval distances between respective pairs of the scatterers may vary with a respective wavelength of light concentrated by a respective one among the thin lenses.

[0027] The image sensor may further include a depth map calculator configured to calculate a defocusing degree of an image that is produced on each of the light-sensing cells, and calculate depth map information about an image that is produced by the incident lights, based on the defocusing degree.

[0028] The image sensor may further include a light filter layer configured to filter a wavelength of light incident on each of the light-sensing cells.